

POSTCONCUSSIVE SYNDROME (PCS) CLINICAL PRACTICE GUIDELINE: PHYSICAL THERAPY

Purpose

- 1 Improve the diagnosis of impairments related to PCS
- 2 Enhance the quality of care and outcomes for PCS patients
- 3 Reduce variations in evaluation and management of PCS
- 4 Ensure efficient management and follow-up for long-term or worsening
- 5 Target Audience: All clinicians diagnosing and managing PCS
- 6 Target Population: Adults and adolescents with PCS
- 7 Focus: Limited quality improvement opportunities
- 8 Not a comprehensive guide; not a standard of care
- 9 Goal: Specific recommendations based on evidence and expert consensus

Background

Definition of Concussion

Mild traumatic brain injury caused by a bump, blow, or jolt to the head or body.

Pathophysiology

Disruption of brain function due to traumatic forces, leading to multiple system impairments.

Symptoms	Physical, cognitive, emotional, and sleep-related; may or may not involve loss of consciousness.
Recovery	Majority recover within 1-2 weeks; 15-20% have persistent symptoms beyond 2 weeks.
Post-Concussion Syndrome (PCS)	Diagnosed based on clinical criteria and subjective symptoms, with no gold standard diagnostic test.
PCS Definition (ICD-10)	Includes 3 or more of the following symptoms: headache, dizziness, fatigue, irritability, insomnia, concentration or memory difficulty
PCS Subtype	Physiologic, vestibulo-ocular, and cervicogenic PCD based on clinical history, physical examination, and graded exercise testing.

Recommendations

Etiology

<p>Prevalence:</p> <ul style="list-style-type: none"> • Estimated 1.7-3 million sports and recreation-related concussions annually.
<p>Acute Concussion Symptoms:</p> <ul style="list-style-type: none"> • Result from a global cerebral energy crisis affecting cell membrane permeability • Ion transport • Neurotransmitter release • Cellular metabolism • Cerebral blood flow

Persistent Symptoms:

- 15-20% of patients have symptoms beyond 2 weeks.

PCS Subtypes:

- Physiologic PCD
- Vestibulo-ocular PCD
- Cervicogenic PCD (refer to *Appendix B*).

Initial Management:

- Cognitive and physical rest are recommended early post-injury.
- Prolonged rest and medication have not shown to speed recovery.

Treatment Prioritization:*Primary symptoms*

- Depression
- Anxiety
- Irritability
- Sleep disorder
- Post-traumatic headache

Secondary symptoms

- Balance
- Dizziness
- Cognitive impairment

Risk Factors**History:**

- Prior concussions
- Physical limitations
- Post-traumatic amnesia
- Post-traumatic migraine
- Skull fracture
- Dizziness
- Cognitive deficits

- Nausea.

Psychiatric and Neurological:

- History of psychiatric disorders
- Learning disabilities
- Migraines
- Family history of migraines.

Demographics:

- Female gender
- Younger age.

Examination**Physical Examination:**

- Assess ROM
- Posture
- Joint mobility
- Strength of cervicothoracic spine
- Shoulder complex.

Screening:

- Neurologic tests
- Vision
- Vestibular
- C-spine clearance.

Outcome Testing**Patient-Reported:**

- Concussion Grading Scale
- Post-concussion Symptom Inventory (PCSI-SR)
- Neck Disability Index (NDI)
- Headache Disability Index (HDI)
- Dizziness Handicap Inventory (DHI)
- Convergence Insufficiency Symptom Survey (CISS)

- SF-36
- SF-12.

Family/Support Reported:

- Post-Concussion Symptom Inventory – Parent (PCSI-P).

Balance-Centered:

- Balance Error Scoring System (BESS)
- Mini-BES Test
- Dynamic Gait Index (DGI)
- Functional Gait Assessment (FGA)
- HiMAT
- Timed Up
- Go (TUG)
- TUG Cognitive
- Modified Sensory Organization Test (mSOT)
- 10-meter walk test (10MWT).

Vestibular-Centered:

- VOR
- VOR cancellation
- Head Impulse Test (HIT)
- Dynamic Visual Acuity (DVA)
- Dix Hall Pike, Joint Position Error
- Motion Sensitivity Quotient (MSQ).

Cervicogenic-Centered:

- Joint Position Error (JPE)
- Postural Stability
- Craniocervical Flexion Test (CCFT)
- Head-Neck Differentiation Test
- Smooth Pursuit Neck Torsion Test (SPNT).

Physiologic-Centered:

- Buffalo Concussion Treadmill Test
- Balke Protocol.

Key Interventions

PCS Subtype	Interventions
Physiologic PCD	<ul style="list-style-type: none"> • Physical and cognitive rest • School/work accommodations • Sub-symptom threshold aerobic exercise programs.
Vestibulo-ocular PCD	<ul style="list-style-type: none"> • Vestibular rehabilitation • Vision therapy • School/work accommodations • Sub-symptom threshold aerobic exercise programs.
Cervicogenic PCD	<ul style="list-style-type: none"> • Cervical spine manual therapy • Head-neck proprioception retraining • Balance and gaze stabilization exercises • Sub-symptom threshold aerobic exercise programs.

Recommendations for Outcome Testing

Patient-Reported Outcome Measures

Measure	Description	Link
Concussion Grading Scale (CGS)	A scale to rate concussion symptoms.	CGS
Graded Symptom Checklist	A tool for assessing concussion symptoms.	Graded Symptom Checklist
Rivermead Post-Concussion Symptom Questionnaire	Measures post-concussion symptoms.	Rivermead
Post-Concussion Symptom Scale	Assesses the severity of concussion symptoms.	Post-Concussion Symptom Scale
Post-Concussion Symptom	Parent version to assess child's	PCSI-Parent

Measure	Description	Link
Inventory - Parent	symptoms.	
Neurobehavioral Symptom Inventory (military-specific)	Assesses neurobehavioral symptoms.	NSI
Neck Disability Index (NDI)	Measures neck disability related to pain.	NDI
Headache Disability Index (HDI)	Assesses the impact of headaches on daily activities.	HDI
Dizziness Handicap Index (DHI)	Evaluates the impact of dizziness on daily life.	DHI
Convergence Insufficiency Symptom Survey (CISS)	Assesses symptoms related to convergence insufficiency.	CISS
SF-36	Health survey measuring overall quality of life.	SF-36
SF-12	Short form health survey.	SF-12

Balance Outcome Measures

Measure	Description	Link
Balance Error Scoring System (BESS)	Evaluates balance and postural stability.	BESS
Mini-BESTest	Assesses balance in different contexts.	Mini-BESTest
Dynamic Gait Index (DGI)	Evaluates dynamic balance during gait.	DGI
Functional Gait Assessment (FGA)	Assesses gait and balance during functional tasks.	FGA
High Level Mobility Assessment Tool (HiMAT)	Measures high-level mobility.	HiMAT
Timed Up and Go (TUG)	Measures mobility and balance.	TUG

Measure	Description	Link
Modified Sensory Organization Test (mSOT)	Assesses sensory integration for balance.	<u>mSOT</u>
10-meter Walk Test (10MWT)	Evaluates walking speed and function.	<u>10MWT</u>

Physiological Testing

Measure	Description	Link
Buffalo Concussion Treadmill Test	Assesses exercise tolerance in concussion.	Refer Below – Test and Measures: Activity Tolerance Testing
Balke Protocol	Used for assessing cardiovascular fitness.	Refer Below – Test and Measures: Activity Tolerance Testing

Vestibular Outcome Measures

Measure	Description	Link
VOR (Vestibulo-Ocular Reflex)	Test of eye movement in response to head movement.	<u>VOR Video</u>
VOR Cancellation	Assesses the ability to suppress the VOR.	<u>VOR Cancellation Video</u>
Head Impulse Test (HIT)	Evaluates the function of the vestibulo-ocular reflex.	<u>HIT</u>
Dynamic Visual Acuity (DVA)	Measures the ability to see clearly during head movement.	DVA
Vestibulo-Oculomotor Screen (VOMS)	A screening tool for vestibular and oculomotor dysfunction.	<u>VOMS</u>
Dix-Hall Pike Maneuver	Tests for benign paroxysmal positional vertigo (BPPV).	<u>Dix Hall Pike</u>

Measure	Description	Link
Joint Position Error (JPE)	Assesses cervical joint position sense.	JPE
Motion Sensitivity Quotient (MSQ)	Evaluates sensitivity to motion stimuli.	MSQ

Cervicogenic Outcome Measures

Measure	Description	Link
Joint Position Error (JPE)	Assesses cervical joint position sense (same as vestibular JPE).	JPE
Craniocervical Flexion Test (CCFT)	Measures the strength and endurance of deep cervical flexors.	CCFT
Head-Neck Differentiation Test	Evaluates head and neck movement control.	Seated Cervical Rotation Test
Smooth Pursuit Neck Torsion (SPNT)	Assesses smooth pursuit eye movements during head rotation.	SPNT Video

History

- **Key Details:** Age, injury date, mechanism, helmet or mouth guard use, symptoms at injury, loss of consciousness, post-traumatic amnesia, current school/work/sport status, exercise habits, sleep changes, psychosocial changes, and previous concussions.
- **Medical History:** Attention Deficit Hyperactivity Disorder (ADHD), seizures, learning disorders, migraines, family history of migraines, anxiety, depression.
- **Medications:** For sleep dysregulation, headaches, memory, concentration, mood disturbances.
- **Assessment Tool:** Concussion Grading Scale (CGS) for current symptoms.

Screening

- **Postural Alignment:** Check for forward head, head tilt, rounded shoulders, scapular winging, pelvic alignment.

- **Neurologic Screen:** Sensation, reflexes, and cranial nerves.
- **Visual/Oculomotor:** Nystagmus, smooth pursuit, saccades, convergence, accommodation.
- **Cervical Clearing:** Assess for compression, distraction, Spurling’s maneuver, and ligament stability.
- **Vestibular:** Joint Position Error (JPE), postural stability, Craniocervical Flexion Test (CCFT), Head-Neck Differentiation Test, Smooth Pursuit Neck Torsion Test (SPNT).

Tests and Measures	
Physical	<ul style="list-style-type: none"> • Cervical • Thoracic • Shoulder range of motion (ROM) • Palpation • Joint mobility • Strength testing.
Outcome Measures	<ol style="list-style-type: none"> 1. Patient-Reported: CGS, Neck Disability Index (NDI), Headache Disability Index (HDI), Dizziness Handicap Inventory (DHI), Convergence Insufficiency Symptom Survey (CISS), SF-36, SF-12. 2. Family/Support Reported: Post-Concussion Symptom Inventory – Parent (PCSI-P). 3. Balance: Balance Error Scoring System (BESS), Mini-BESTest, Dynamic Gait Index (DGI), Functional Gait Assessment (FGA), High Level Mobility Assessment Tool (HiMAT), Timed Up and Go (TUG), Sensory Organization Test (SOT), 10-meter Walk Test (10MWT). 4. Vestibular: VOR, VOR Cancellation, Head Impulse Test (HIT), Dynamic Visual Acuity (DVA), Dix Hall Pike, Joint Position Error (JPE), Motion Sensitivity Quotient (MSQ), Vestibulo-Oculomotor Screen (VOMS). 5. Cervicogenic: JPE, Postural Stability, Craniocervical Flexion Test (CCFT), Head-Neck Differentiation Test, SPNT. 6. Activity Tolerance: Buffalo Concussion Treadmill Test (BCTT),

Balke Protocol

Buffalo Concussion Treadmill Test (BCTT)

- **Speed:** 3.6 mph for patients $\geq 5'5"$, 3.2 mph for $< 5'5"$. Adjust as needed.
- **Protocol:** Start at 0% incline, increase by 1% each minute, then increase speed by 0.4 mph if tolerated.
- **Stopping Criteria:** Increase in PCS symptoms, 20-minute cap, RPE of 19-20. Assess RPE, HR, symptoms, BP.

Balke Protocol

- **Speed and Incline:** Start at 3.3 mph with 0% incline, increase grade by 2% after 1 min, then 1% per minute.
- **Monitoring:** Measure BP every 2 minutes, HR, RPE every minute, assess symptom changes.

Patient Education

- **Importance:** Brief education is effective; includes symptoms, recovery timeline, management, gradual reintegration, and accessing support.
- **Resources:** [Education Handouts](#), [Recovery Guide](#).

Recommendations for Physiologic PCD Interventions

Etiology	
Persistent Symptom	<ul style="list-style-type: none">• Altered cell membrane permeability• Ion transport• Neurotransmitter release• Cellular metabolism• Cerebral blood flow (CBF)
Metabolic Recovery	<ul style="list-style-type: none">• Athletes reporting symptom resolution at 3-15 days may not have complete metabolic recovery until 30

	<p>days</p> <ul style="list-style-type: none"> • Mitochondrial function potentially requiring an additional 15 days if a second concussion occurs.
<p>Symptom Exacerbation</p>	<ul style="list-style-type: none"> • Symptoms may worsen with cognitive • Physical activity due to ongoing cerebral metabolic energy deficiency.
<p>Autonomic Dysfunction</p>	<ul style="list-style-type: none"> • Increased sympathetic nervous system activity (e.g., elevated resting heart rate) • Correlates with TBI severity • Improves with recovery.
<p>Exercise Testing and Rehabilitation</p>	<ul style="list-style-type: none"> • Should be considered only if symptoms persist for 3-6 weeks. • Follow OSU's Return to Sport Guidelines for the first 14 days • Avoid treadmill testing before 3 weeks post-injury for symptoms lasting more than 10 day • Adhering to the Return to Activity protocol.

Recommendations for Physiologic PCD Interventions

Physical and Cognitive Rest

- **Premature Exercise Risks:** Early exercise (within the first week post-injury) can impair cognitive performance and reduce brain-derived neurotrophic factor (BDNF).
- **Management:** Patients showing symptoms at rest should be managed with conservative cognitive and physical rest.
- **Children:** Continued rest is especially recommended for children.

Prognostic Utility

- **Exercise Intolerance Testing:** Emerging as a key biomarker for concussion recovery.
- **Recovery Prediction:** Exercise intolerance (measured shortly after injury) strongly predicts recovery duration. A low heart rate threshold (<135 bpm) indicates a higher likelihood of prolonged recovery.

Sub-symptom Threshold Aerobic Exercise Program

- **Post-Injury Benefits:** Exercise 14-21 days post-injury can improve cognitive performance and increase BDNF levels, which are dependent on injury severity.
- **Program Consideration:** Recommended for adolescents and adults with persistent symptoms beyond 3 weeks.
- **Protocol:**
 1. Use the Buffalo Concussion Treadmill Test (BCTT) to establish a sub-symptom threshold heart rate.
 2. Decrease this threshold by 15-20% to determine the prescribed heart rate.
 3. Follow OSU's Return to Activity Protocol, advancing through phases as symptoms allow.
 4. Physiological resolution is indicated by the ability to exercise at 85-90% of age-predicted HRmax for 20 minutes without symptom exacerbation for several days.
 5. Athletes must be cleared by their physician before returning to sports.

Recommendations for Vestibulo-ocular PCD Interventions

Etiology	
System Interactions	The vestibular, oculomotor, and somatosensory systems interact with various brain and spinal cord structures, affecting balance and vision.
Common Symptoms	Include vertigo, dizziness, nausea, light-headedness, gait instability, and postural instability. These can be due to vestibular dysfunction or related conditions such as:

	<ol style="list-style-type: none"> 1. Vestibulo-ocular Reflex (VOR): Stabilizes gaze during head movements. 2. Vestibulo-spinal Reflex (VSR): Coordinates body positioning during movement. 3. Conditions: BPPV, labyrinthine concussion, perilymphatic fistula, endolymphatic hydrops, otolith disorders, and central vestibular disorders, affecting up to 46% of concussion patients.
Visual Symptoms	Include blurred vision, difficulty tracking objects, and motion sensitivity, which may require referral to a vision specialist or occupational therapist (OT).

Interventions	
BPPV	Treatment: Use repositioning techniques to manage Benign Paroxysmal Positional Vertigo.
Eye-Head Coordination	<ul style="list-style-type: none"> • Exercises: VORx1 and VORx2 (yaw and pitch planes). • Adjustments: Modify frequency, base of support (BOS), surface stability, and visual background complexity. • Prevalence: Prescribed in 95% of patients.
Sitting Balance	<ul style="list-style-type: none"> • Exercises: Supported and unsupported sitting, weight shifts, bouncing. • Prevalence: Prescribed in 88% of patients.
Standing Static Balance	<ul style="list-style-type: none"> • Exercises: Modify BOS with exercises like Romberg, tandem, single-leg stance; perform weight shifting in various directions. • Prevalence: Prescribed in 88% of patients.
Standing Dynamic Exercises	<ul style="list-style-type: none"> • Exercises: Sit to stand, marching, stepping forward/backward, stepping to the side, turning around.

	<ul style="list-style-type: none"> • Prevalence: Prescribed in 76% of patients
Ambulation	<ol style="list-style-type: none"> 1. Exercises: Walking forward/backward, tandem walking, stair navigation, whole body turns, and head on body turns. 2. Prevalence: Prescribed in 76% of patients.
Sensory Re-integration	<p>Adjustments: Modify stability of surface (foam, rocker board), BOS, trunk and arm positioning, incorporate head movements, visual integration (eyes open/closed, distraction), and dual tasking.</p> <p>Refer to Appendix F for progression details.</p>

Recommendations for Cervicogenic PCD Interventions

Etiology	
Injury Impact	Structural and functional injuries to the cervical spine can cause symptoms like headache, dizziness, blurred vision, and vertigo. Rotational forces can affect nerve tracts and proprioceptive fibers
Cervical Afferents	Carry proprioceptive information to the cerebellum and thalamus, influencing head and neck position through various reflexes (cervicocollic, vestibulocollic, cervico-ocular)
Cervicogenic Dizziness	Diagnosed by exclusion, characterized by neck pain, stiffness, dizziness, and impaired balance without central or peripheral vestibular involvement.
Risk Factors	Children and adolescents may be at higher risk due to differences in muscle strength, ligamentous laxity, and cervical spine mobility. Increased neck strength is associated with a lower risk of concussion
Interventions	
Cervical Mobility and Pain	Techniques:

Management:	<ul style="list-style-type: none"> • Range of Motion: Passive and active. • Soft Tissue Mobilization: Addressing cervical and cervico-thoracic regions. • Mobilizations: Grade I-IV, with minimal evidence supporting Grade V manipulations. • Mulligan Techniques: Sustained Natural Apophyseal Glide (SNAGs). • Traction/Distrraction: For pain relief. • Muscle Energy Techniques: Contract/relax methods
Cervical Proprioception	Training: <ol style="list-style-type: none"> 1. Joint Position Error Training: Progress to tracing figures and complex designs. 2. Gaze Stabilization: VORx1 and VORx2 exercises.
Cervical Strengthening	Focus: <ul style="list-style-type: none"> • Deep Neck Flexors: Strengthening for stabilization. • Cervical Extensors: Enhancing overall neck strength
Postural Retraining:	Methods: <ul style="list-style-type: none"> • Biofeedback: Use mirrors for posture correction. • Ergonomic Training: Education on proper posture and movement in various activities. • Movement Control: Training for sport-specific tasks, job-related activities, and daily living. • Strengthening: <ol style="list-style-type: none"> 1. Abdominal/Trunk: Core strengthening. 2. Scapular: Strengthening for improved shoulder stability.

Appendix A: PCS Diagnostic Criteria

ICD-10 Diagnostic Criteria for Post-Concussion Syndrome (PCS)

- **A.** History of head trauma with loss of consciousness occurring within 4 weeks before symptom onset.
- **B.** Symptoms must be present in 3 or more of the following categories:
 - Headache, dizziness, malaise, fatigue, noise intolerance.
 - Irritability, depression, anxiety, emotional instability.
 - Subjective difficulties with concentration, memory, or intellectual functioning without significant neuropsychological impairment.
 - Insomnia.
 - Reduced alcohol tolerance.
 - Preoccupation with symptoms, fear of brain damage, hypochondriacal concerns, and adoption of the sick role.

DSM-IV Diagnostic Criteria for Postconcussional Disorder

- **A.** History of head trauma causing significant cerebral concussion, characterized by:
 - Loss of consciousness.
 - Posttraumatic amnesia.
 - (Less commonly) Posttraumatic seizures.
- **B.** Neuropsychological testing or cognitive assessment showing difficulty with:
 - Attention (concentrating, shifting focus, multitasking).
 - Memory (learning, recall).
- **C.** Three or more of the following symptoms occurring shortly after the trauma and lasting at least 3 months:
 - Fatigue.
 - Disordered sleep.
 - Headache.
 - Vertigo or dizziness.
 - Irritability or aggression with minimal provocation.

- Anxiety, depression, or mood instability.
 - Personality changes (e.g., social or sexual inappropriateness).
 - Apathy or lack of spontaneity.
- **D.** Symptoms either start after head trauma or significantly worsen pre-existing symptoms.
 - **E.** Symptoms cause significant impairment in social or occupational functioning, showing a notable decline from previous levels of function. In children, this may manifest as worsening school or academic performance.
 - **F.** Symptoms do not meet criteria for Dementia Due to Head Trauma and are not better explained by other conditions.

Appendix B: Differential Diagnosis of PCD Subtypes

Aspect	Physiologic PCD	Vestibulo-ocular PCD	Cervicogenic PCD
Pathophysiology	<ul style="list-style-type: none"> • Altered neuronal depolarization, cell membrane permeability • Mitochondrial function • Cellular metabolism • Cerebral blood flow. 	<ul style="list-style-type: none"> • Dysfunction in vestibular and oculomotor systems. 	<ul style="list-style-type: none"> • Muscle trauma and inflammation affecting cervical spine proprioception.
Predominant Symptoms	<ul style="list-style-type: none"> • Headache worsened by physical/cognitive activity • Nausea, vomiting, 	<ul style="list-style-type: none"> • Dizziness, vertigo, nausea • Lightheadedness, gait instability, postural instability 	<ul style="list-style-type: none"> • Neck pain, stiffness, decreased range of motion • Occipital headaches

Aspect	Physiologic PCD	Vestibulo-ocular PCD	Cervicogenic PCD
	<ul style="list-style-type: none"> • photophobia, phonophobia • Dizziness, fatigue • Difficulty concentrating, slowed speech 	<ul style="list-style-type: none"> • Blurred/double vision • Difficulty tracking objects, motion sensitivity, eye strain 	<ul style="list-style-type: none"> • worsened by head movements • Lightheadedness, postural imbalance
Physical Exam Findings	<ul style="list-style-type: none"> • No focal neurological deficits • Elevated resting heart rate • Impaired balance and gait • Standardized testing abnormalities 	<ul style="list-style-type: none"> • Impaired vestibulo-ocular reflex (VOR) • Issues with fixation, convergence, saccades • No focal neurological deficits 	<ul style="list-style-type: none"> • Decreased cervical lordosis and range of motion • Tenderness in paraspinal and sub-occipital muscles • Impaired head-neck position sense
Graded Treadmill Test	<ul style="list-style-type: none"> • Often terminated early due to symptom onset or exacerbation 	<ul style="list-style-type: none"> • Patients usually reach maximal exertion without worsening vestibulo-ocular symptoms 	<ul style="list-style-type: none"> • Patients typically reach maximal exertion without worsening cervicogenic symptoms
Management Options	<ul style="list-style-type: none"> • Physical and cognitive rest • School accommodations 	<ul style="list-style-type: none"> • Vestibular rehabilitation • Vision therapy • School accommodations 	<ul style="list-style-type: none"> • Cervical spine manual therapy • Head-neck proprioception re-training

Aspect	Physiologic PCD	Vestibulo-ocular PCD	Cervicogenic PCD
	<ul style="list-style-type: none"> Sub-symptom threshold aerobic exercise for adolescents and adults 	<ul style="list-style-type: none"> Sub-symptom threshold aerobic exercise for adolescents and adults 	<ul style="list-style-type: none"> Balance and gaze stabilization exercises Sub-symptom threshold aerobic exercise for adolescents and adults

Appendix C: Dr. Sujan Goju's Clinic Concussion Grading Scale

Question	Options
1. Over the past week, my sleeping pattern has changed.	<input type="checkbox"/> Yes <input type="checkbox"/> No (If NO, skip to #2)
a. Have you been taking naps during the middle of the day?	<input type="checkbox"/> Yes <input type="checkbox"/> No
b. Are you waking during the night?	<input type="checkbox"/> Yes <input type="checkbox"/> No
2. Over the past week, my participation in work or school has been % of what it would be normally.	[Insert Percentage]
3. Over the past week, my participation in physical activity (sports, working out, etc.) has been % of what it would be normally.	[Insert Percentage]
4. Do you feel like you are putting more effort into maintaining schoolwork/grades and/or work productivity?	0 1 2 3 4 5 6 (No More Effort to A Lot More Effort)
5. Please indicate the type of visual changes you are experiencing:	<input type="checkbox"/> Eye Fatigue <input type="checkbox"/> Double Vision <input type="checkbox"/> Blurry Vision <input type="checkbox"/> Other <input type="checkbox"/> N/A

Question	Options
6. Do your symptoms get WORSE with physical activity?	<input type="checkbox"/> Yes <input type="checkbox"/> No
7. Do your symptoms get WORSE with thinking/cognitive activity?	<input type="checkbox"/> Yes <input type="checkbox"/> No
8. Do your symptoms IMPROVE with physical rest?	<input type="checkbox"/> Yes <input type="checkbox"/> No
9. Do your symptoms IMPROVE with thinking/cognitive rest?	<input type="checkbox"/> Yes <input type="checkbox"/> No

Symptom Severity Ratings

Symptom	None	Mild	Moderate	Severe
Headache	0	1/2	3/4	5/6
“Pressure in Head”	0	1/2	3/4	5/6
Neck Pain	0	1/2	3/4	5/6
Nausea or Vomiting	0	1/2	3/4	5/6
Dizziness	0	1/2	3/4	5/6
Blurred Vision	0	1/2	3/4	5/6
Balance Problems	0	1/2	3/4	5/6
Sensitivity to Light	0	1/2	3/4	5/6
Sensitivity to Noise	0	1/2	3/4	5/6
Feeling Slowed Down	0	1/2	3/4	5/6
Feeling Like “In a Fog”	0	1/2	3/4	5/6
Don’t Feel Right	0	1/2	3/4	5/6
Difficulty Concentrating	0	1/2	3/4	5/6
Difficulty Remembering	0	1/2	3/4	5/6
Fatigue or Low Energy	0	1/2	3/4	5/6

Symptom	None	Mild	Moderate	Severe
Confusion	0	1/2	3/4	5/6
Drowsiness	0	1/2	3/4	5/6
Trouble Falling Asleep	0	1/2	3/4	5/6
More Emotional	0	1/2	3/4	5/6
Irritability	0	1/2	3/4	5/6
Sadness	0	1/2	3/4	5/6
Nervous or Anxious	0	1/2	3/4	5/6
Sleeping More Than Usual	0	1/2	3/4	5/6
Sleeping Less Than Usual	0	1/2	3/4	5/6
Difficulty Sleeping Soundly	0	1	2	3-6
ringing in Ears	0	1	2	3-6
Numbness or Tingling	0	1	2	3-6

Appendix D: Buffalo Concussion Treadmill Test

Name	_____	Date	_____
Symptoms	_____		
HRmax Calculation	220 – age = _____	Resting HR	_____
		Resting BP	_____

Min	HR	BP	RPE	Symptom Change	Observations
0					
1					

Min	HR	BP	RPE	Symptom Change	Observations
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
2-min post					
5-min post					

Notes:

Appendix E: Return to Activity Protocol

General Guidelines

- Each phase lasts *1-2 weeks*.
- Progress through phases based on patient tolerance, avoiding all signs and symptoms of concussion.
- Engage in a monitored home program *6 days per week*.

Phase I: No Impact

- **Cardiovascular Conditioning**
 - 30-50% max heart rate for 15-20 minutes
 - Activities: Elliptical, stationary bike, spinner
- **Strengthening**
 - 50% max time for 4-way plank
 - Upper and lower body strengthening without resistance, low sets, low reps

Phase II: Low Impact

- **Cardiovascular Conditioning**
 - 30-50% max heart rate for 20-30 minutes
 - Intervals: 10 min at 30-50%, 3-5 min at 60-80%, 5 min at 30-50%, 3-5 min at 60-80%, 5-10 min at 30-50%
 - 60-80% max heart rate for 5-10 minutes
 - Activities: Elliptical, stationary bike, spinner, walking on treadmill
- **Strengthening/Balance**
 - 75-100% max time for 4-way plank
 - Body weight strengthening: low sets, high reps; low sets, low reps
 - Static balance activities on firm surface, eyes open (BESS)

Phase III: Impact

- **Cardiovascular Conditioning**
 - Running on treadmill to tolerance at 60-80% max heart rate for 10-15 minutes
- **Strengthening/Balance**
 - 100% max time for 4-way plank, dynamic core strength
 - Body weight strengthening: low sets, high reps
 - Resistance strengthening: low sets, low reps
 - Progress balance activities to eyes closed (BESS)

Phase IV: Agility

Cardiovascular Conditioning

- Warm up: 60% max heart rate for 15 minutes
- Circuit training: 60-80% max HR for 30 minutes (Borg 11-14)
- Intervals: 30 seconds each, adjust as needed for symptoms

Cycle	Cardio LE	Strength	Balance	Cardio UE	Strength	Agility	Cardio Core	Rest
Cycle 1	Jog	Squats	SLS Eyes Closed	Jog	T-band Shoulder Extension	Box Drill	Jog Prone Plank	2 min
Cycle 2	Jog	Walking Lunges	SLS with UE Chop	Jog	Push-ups (modified)	Pro- Agility (T- drill)	Jog R side Plank	2 min
Cycle 3	Jog	T-Band Resisted Sidestep	Star Drill	Jog	T-Band Star Pulls	W- Drill	Jog L side Plank	2 min

Phase V: Return to Activity

Cardiovascular Conditioning

- Warm up: 60-80% max heart rate for 20-30 minutes
- Circuit training: 60-80% max HR for 30 minutes (Borg scale 14-18)
- Intervals: 30-45 seconds each, adjust as needed for symptoms

Cycle	Cardio LE	Strength	Balance	Cardio UE	Strength	Agility	Cardio Core	Rest
Cycle 1	Jog	2-foot Jumps in Place	SLS on Foam + Rebounder	Jog	Med Ball Slams	Box Drill	Jog Med Ball Twists	2 min
Cycle 2	Jog	Lateral Bench Jump Plyos	SLS with UE Chop	Jog	T-Band Rows	Pro-Agility (T-Drill)	Jog R side Plank with Rotation	2 min
Cycle 3	Jog	Lunge Hops/Switch	SLS with Floor Touch	Jog	Med Ball Chest Pass (wall)	W-Drill	Jog L side Plank with Rotation	2 min

Phase VI: Return to Full Contact Practice

- Check-in briefly to determine if physical therapy needs persist.

Appendix F: Return to Sport Protocol

Pre-Protocol Requirements

- **Rest Period:** Athlete must complete a 24-48 hour period of cognitive and physical rest. Length of rest will be determined by a physician or appropriate medical professional.
- **Symptom Monitoring:** Symptom checklist completed by athlete before and after each treatment/exercise session.
- **Criteria for Progression:** If symptoms are elevated with exercise beyond permissible criteria, do not progress to the next phase. Return the athlete to the previous phase which did not elevate symptoms. Communication with a physician is required before advancing beyond day/phase 3.
- **Referral:** If unable to progress through phase 5 after 14 days, refer the athlete back to a physician for additional multidisciplinary testing. Consider Buffalo Concussion Treadmill Testing (BCTT).

Day/Phase 1: Light Aerobic Activity (30-40% max HR)

- **Warm-Up:** 5 minutes
- **Duration:** 15 minutes

Day/Phase 2: Moderate Aerobic Activity (40-60% max HR)

- **Warm-Up:** 5 minutes
- **Duration:** 15 minutes
- **Circuit-Based Exercise:** 15 minutes, each cycle completed one time, each exercise performed for 30 seconds

Cycle	Exercise	Rest
Cycle 1	Jog, Squats, Jog, Push-ups, Jog, Lunges, Jog, Bridges, Jog	2 min rest
Cycle 2	Jog, Squats, Jog, Push-ups, Jog, Lunges, Jog, Bridges, Jog	2 min rest
Cycle 3	Single Leg Balance on Right (30 sec), Single Leg Balance on Left (30 sec), Prone Plank (30 sec-1 min)	-

Day/Phase 3: Higher Intensity Aerobic Activity (60-80% max HR)

- **Warm-Up:** 5 minutes
- **Duration:** 20 minutes
- **Circuit-Based Exercise:** 15 minutes, each cycle completed one time, each exercise performed for 30 seconds
- **Sport-Specific Non-Contact Drills:** 5 minutes

Cycle	Exercise	Rest
Cycle 1	Jog, Hops, Jog, Skips, Jog, Lunge Hops, Jog, Box Drill, Jog	2 min rest
Cycle 2	Jog, Hops, Jog, Skips, Jog, Lunge Hops, Jog, Box Drill, Jog	2 min rest
Cycle 3	Single Leg Stance with Perturbations (30 sec), Side Plank Left (30 sec), Side Plank Right (30 sec)	-

Day/Phase 4: Return to Practice (Non-Contact Drills)

- **Activities:** Non-contact sport-specific drills to tolerance. Initiate harder training drills, agility, and passing drills. May start progressive resistance training.
- **Communication:** Required with a physician before advancing beyond this phase.

Day/Phase 5: Full Contact Practice

Day/Phase 6: Return to Sport

Appendix G: Modifiers for Vestibular Rehabilitation

Each phase lasts 1 to 2 weeks, with progression based on patient tolerance, avoiding all concussion signs and symptoms. Patients should participate in a monitored home program 6 days per week.

Modifier	Choices
Posture	1: Sitting, 2: Standing, 3: Walking, NA/NS
Surface	1: Level, 2: Foam, 3: Uneven, 4: Obstacle, 5: Stairs, 6: Ramps, NA/NS
Base of Support	1: Feet apart, 2: Feet together, 3: Semi-tandem, 4: Tandem, NA/NS
Trunk Position	1: Upright, 2: Leaning, 3: Rotated, NA/NS
Arm Position	1: Weight-bearing, 2: Close to body, 3: Away from body, 4: Reaching, 5: Carrying, 6: Picking up objects, 7: Juggling, NA/NS
Head Movement Direction	1: Still, 2: Yaw, 3: Pitch, 4: Roll, NA/NS
Direction of Whole Body Movements	1: Anterior-posterior, 2: Medial-lateral, 3: Multi-directional, NA/NS
Visual Movement	1: Eyes closed, 2: Eyes open, 3: Complex patterns, NA/NS

Modifier	Choices
Cognitive Dual Task	1: Yes, 2: No
Special Circumstances	Note specific details, e.g., VORx1 exercise with near or far target

Ensure all exercises are tailored to individual patient needs and adjusted based on progress and symptomatology.